DOCUMENT RESUME

ED 151 157 SE 023 498

AUTHOR Cutler, Edward B.
TITLE Marine Flora and Fauna of the Northeastern United States. Sipuncula.
INSTITUTION National Oceanic and Atmospheric Administration (DOC), Rockville, Md. National Marine Fisheries Service.
REPORT NO NOAA-TR-NMFS-Circ-403
PUB DATE Jul 77
NOTE 14p.; For related document, see SE 023 494; Contains occasional small print
AVAILABLE FROM Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock Number 003-012-00404-0, $0.90)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Biology; College Science; Higher Education; *Marine Biology; *Oceanology; Science Education; *Scientific Research; Taxonomy; *Zoology
IDENTIFIERS *Keys (Biology); *Sipuncula

ABSTRACT

This report is part of a subseries entitled "Marine Flora and Fauna of the Northeastern United States" which is designed for use by biology students, biologists, biological oceanographers and informed laymen. Contents of this report include: (1) Introduction; (2) Key to Sipuncula (Peanut Worms); (3) Annotated Systematic List of Species; (4) Selected Bibliography; (5) Index to Scientific Names; and (6) Editor's Comments. This report is an account of the five species of Sipuncula living in shallow marine waters (down to 200 m) from Maine to Virginia. Four of these are widespread elsewhere in the world. An introduction to their biology, their identification and classification, are discussed. (MR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

403

ED151157

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

NOAA Technical Report NMFS Circular 403

Marine Flora and Fauna of the Northeastern United States. Sipuncula

Edward B. Cutler

July 1977

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

SE 023 498

2

NOAA TECHNICAL REPORTS

National Marine Fisheries Service, Circulars

The major responsibilities of the National Marine Fisheries Service (NMFS) are to monitor and assess the abundance and geographic distribution of fishery resources, to understand and predict fluctuations in the quantity and distribution of these resources, and to establish levels for optimum use of the resources. NMFS is also charged with the development and implementation of policies for managing national fishing grounds, development and enforcement of domestic fisheries regulations, surveillance of foreign fishing off United States coastal waters, and the development and enforcement of international fishery agreements and policies. NMFS also assists the fishing industry through marketing service and economic analysis programs, and mortgage insurance and vessel construction subsidies. It collects, analyzes, and publishes statistics on various phases of the industry.

The NOAA Technical Report NMFS Circular series continues a series that has been in existence since 1941. The Circulars are technical publications of general interest intended to aid conservation and management. Publications that review in considerable detail and at a high technical level certain broad areas of research appear in this series. Technical papers originating in economics studies and from management investigations appear in the Circular series.

NOAA Technical Report NMFS Circulars are available free in limited numbers to governmental agencies, both Federal and State. They are also available in exchange for other scientific and technical publications in the marine sciences. Individual copies may be obtained (unless otherwise noted) from D822, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235. Recent Circulars are:

365. Processing EASTROPAC STD data and the construction of vertical temperature and salinity sections by computer. By Forrest R. Miller and Kenneth A. Bliss. February 1972, iv + 17 p., 8 figs., 3 app. figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

366. Key to field identification of anadromous juvenile salmonids in the Pacific Northwest. By Robert J. MacConnell and George R. Snyder. January 1972, iv + 6 p., 4 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

367. Engineering economic model for fish protein concentration processes. By K. K. Anonas, L. C. Durilla, R. C. Ernst, J. W. Gentry, M. B. Hale, and J. M. Marchello. October 1972, iii + 175 p., 6 figs., 6 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

368. Cooperative Gulf of Mexico estuarine inventory and study, Florida: Phase I, area description. By J. Kneeland McNulty, William N. Lindall, Jr., and James E. Sykes. November 1972, vii + 126 p., 46 figs., 62 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

369. Field guide to the anglefishes (Pomacanthidae) in the western Atlantic. By Henry A. Feddern. November 1972, iii + 10 p., 17 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

370. Collecting and processing data on fish eggs and larvae in the California Current region. By David Kramer, Mary J. Kalin, Elizabeth G. Stevens, James R. Thrailkill, and James R. Zweifel. November 1972, iv + 38 p., 38 figs., 2 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

371. Ocean fishery management: Discussion and research. By Adam A. Sokoloski (editor). (17 papers, 24 authors.) April 1973, vi + 173 p., 38 figs., 32 tables, 7 app. tables.

372. Fishery publications, calendar year 1971: Lists and indexes. By Thomas A. Manar. October 1972, iv + 24 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

374. Marine flora and fauna of the northeastern United States. Annelida: Oligochaeta. By David G. Cook and Ralph O. Brinkhurst. May 1973, iii + 23 p., 82 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

375. New Polychaeta from Beaufort, with a key to all species recorded from North Carolina. By John H. Day. July 1973, xiii + 140 p., 18 figs., 1 table. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

376. Bottom-water temperatures on the continental shelf, Nova Scotia to New Jersey. By John B. Colton, Jr. and Ruth R. Stoddard. June 1973, iii + 55 p., 15 figs., 12 app. tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

377. Fishery publications, calendar year 1970: Lists and indexes. By Mary Ellen Engett and Lee C. Thorson. December 1972, iv + 34 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

378. Marine flora and fauna of the northeastern United States. Protozoa: Ciliophora. By Arthur C. Borror. September 1973, iii + 62 p., 5 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

379. Fishery publications, calendar year 1969: Lists and indexes. By Lee C. Thorson and Mary Ellen Engett. April 1973, iv + 31 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

380. Fishery publications, calendar year 1968: Lists and indexes. By Mary Ellen Engett and Lee C. Thorson. May 1973, iv + 24 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

381. Fishery publications, calendar year 1967: Lists and indexes. By Lee C. Thorson and Mary Ellen Engett. July 1973, iv + 22 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

382. Fishery publications, calendar year 1966: Lists and indexes. By Mary Ellen Engett and Lee C. Thorson. July 1973, iv + 19 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

383. Fishery publications, calendar year 1965: Lists and indexes. By Lee C. Thorson and Mary Ellen Engett. July 1973, iv + 12 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

384. Marine flora and fauna of the northeastern United States. Higher plants of the marine fringe. By Edwin T. Moul. September 1973, iii + 60 p., 109 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

385. Fishery publications, calendar year 1972: Lists and indexes. By Lee C. Thorson and Mary Ellen Engett. November 1973, iv + 23 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

386. Marine flora and fauna of the northeastern United States. Pycnogonida. By Lawrence R. McCloskey. September 1973, iii + 12 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

387. Marine flora and fauna of the northeastern United States. Crustacea: Stomatopoda. By Raymond B. Manning. February 1974, iii + 6 p., 10 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Continued on inside back cover

014110

NOAA Technical Report NMFS Circular 403

Marine Flora and Fauna of the Northeastern United States. Sipuncula

Edward B. Cutler

July 1977

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

National Oceanic and Atmospheric Administration
Robert M. White, Administrator

National Marine Fisheries Service
Robert W. Schoning, Director

For Sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 Stock No. 003-012-00404-0

FOREWARD

This issue of the "Circulars" is part of a subseries entitled "Marine Flora and Fauna of the Northeastern United States." This subseries will consist of original, illustrated, modern manuals on the identification, classification, and general biology of the estuarine and coastal marine plants and animals of the northeastern United States. Manuals will be published at irregular intervals on as many taxa of the region as there are specialists available to collaborate in their preparation.

The manuals are an outgrowth of the widely used "Keys to Marine Invertebrates of the Woods Hole Region," edited by R. I. Smith, published in 1964, and produced under the auspices of the Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Mass. Instead of revising the "Woods Hole Keys," the staff of the Systematics-Ecology Program decided to expand the geographic coverage and bathymetric range and produce the keys in an entirely new set of expanded publications.

The "Marine Flora and Fauna of the Northeastern United States" is being prepared in collaboration with systematic specialists in the United States and abroad. Each manual will be based primarily on recent and ongoing revisionary systematic research and a fresh examination of the plants and animals. Each major taxon, treated in a separate manual, will include an introduction, illustrated glossary, uniform originally illustrated keys, annotated check list with information when available on distribution, habitat, life history, and related biology, references to the major literature of the group, and a systematic index.

These manuals are intended for use by biology students, biologists, biological oceanographers, informed laymen, and others wishing to identify coastal organisms for this region. In many instances the manuals will serve as a guide to additional information about the species or the group.

Geographic coverage of the "Marine Flora and Fauna of the Northeastern United States" is planned to include organisms from the headwaters of estuaries seaward to approximately the 200-m depth on the continental shelf from Maine to Virginia, but may vary somewhat with each major taxon and the interests of collaborators. Whenever possible representative specimens dealt with in the manuals will be deposited in reference collections of the major museums in the region.

After a sufficient number of manuals of related taxonomic groups have been published, the manuals will be revised, grouped, and issued as special volumes. These volumes will thus consist of compilations of individual manuals within phyla such as the Coelenterata, Arthropoda, and Mollusca, or of groups of phyla.

CONTENTS

	Page
Introduction	1
Key to the Sipuncula, Maine to Virginia	3
Annotated systematic list of species	5
Selected bibliography	5
Index to scientific names	6
Acknowledgments	7
Coordinating editor's comments	7

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

Marine Flora and Fauna of the Northeastern United States. Sipuncula

EDWARD B. CUTLER[1]

ABSTRACT

This report includes an account of the five species of Sipuncula living in shallow waters (down to 200 m) from Maine to Virginia. Four of these are widespread elsewhere in the world—*Golfingia eremita, G. margaritacea, G. minuta,* and *Phascolion strombi*. *Phascolopsis gouldi* is endemic to the east coast of North America. An introduction to their biology, an annotated systematic list, selected bibliography, and an illustrated key are presented.

INTRODUCTION

The Sipuncula (peanut worms) are marine, sedentary, vermiform coelomates which lack any trace of segmentation, although related to the annelids. They are found in all oceans and live within the sediment or inside a protective shelter such as a discarded mollusc shell (pteropod, gastropod, or scaphopod), foraminiferan test, polychaete tube, or crevice in rock or coral.

Sipunculans have two body regions: the trunk (or body) and a retractable introvert (Fig. 1A). The mouth is located at the tip of the introvert and is usually surrounded by tentacles of varying degrees of development and complexity. Behind the tentacular region is a zone which may bear chitinous, posteriorly directed hooks which are scattered or arranged in regular rings. The introvert may be less than half the trunk length in some species to many times its length in others. The demarcation between these two regions is usually defined by the abrupt narrowing of the diameter where the introvert begins. This area generally coincides with the position of the anus or nephridiopores, or both. Sipunculans range in trunk length from less than 2 mm to over 300 mm, but in the northeastern Atlantic they are more commonly between 3 and 30 mm.

The shape of the body may vary from almost spherical to cylindrical. In those forms inhabiting discarded gastropod shells, the living worm retains the spiral shape of its shell even after it is removed. Sipunculans have a variety of epidermal structures such as papillae, holdfasts, and hooks. The papillae are glandular structures which produce material which is thought may function in constructing or maintaining burrows or tubes. Generally, pigmentation is scant but when present, it is in shades of yellow or brown and is not ordinarily useful for identification.

The internal anatomy of these worms is relatively simple (Fig. 1B). The digestive tract has a straight esophagus and a double-coiled intestine extending towards the posterior end of the body. The tract terminates in a rectum, which may bear a small caecum. The dorsal anus is located at the anterior end of the trunk except in a few species where it is in the midregion and in one genus (*Onchnesoma*) where it is on the introvert. The distal part of the rectum is anchored to the body wall by a sheet of muscle tissue referred to as the wing muscles. Near the anus a long strand of muscle tissue originates from the body wall and extends down the center of the gut coil, increasing its stability; this is the spindle muscle. It may terminate within the coil or extend beyond to the posterior end of the trunk. In addition, the worm may have fixing muscles, which are fine muscle strands anchoring the gut coils or esophagus to the body wall.

One or usually two simple, saclike nephridia (sometimes called segmental organs) open on the ventral side at the anterior end of the trunk. The nephridia are always attached to the body wall at the nephridiopores and sometimes are attached by more extensive mesentery along some portion of their length. The nephridiopores themselves, in most species, are not discernible externally. The longitudinal and circular muscles of the body wall are frequently arranged in smooth, uniform layers but also may be gathered into bundles. One, two, or four retractor muscles control the introvert. A ventral nerve cord with lateral nerves and a pair of cerebral ganglia are present. Two or four pigmented eyespots may be present on the cerebral ganglia.

Our knowledge of the reproductive biology of east coast sipunculans is scanty. Rice (1967, 1973, 1975) has given the most current statement of our knowledge on developmental patterns in Sipuncula. Gerould (1907) gave an account of the development of *Phascolopsis gouldi*. Good information on breeding cycles is unavailable for most species. Gametes are produced from a strip of gonadal tissue at the base of the ventral retractor muscles. They are released into the coelom at an early stage where they undergo the remainder of their growth and differentiation as freely floating cells.

Gibbs (1975), working with *Golfingia minuta* populations, found monoecious animals in the eastern Atlantic but not in the western Atlantic. With the possible

[1] Utica College of Syracuse University, Utica, NY 13502.

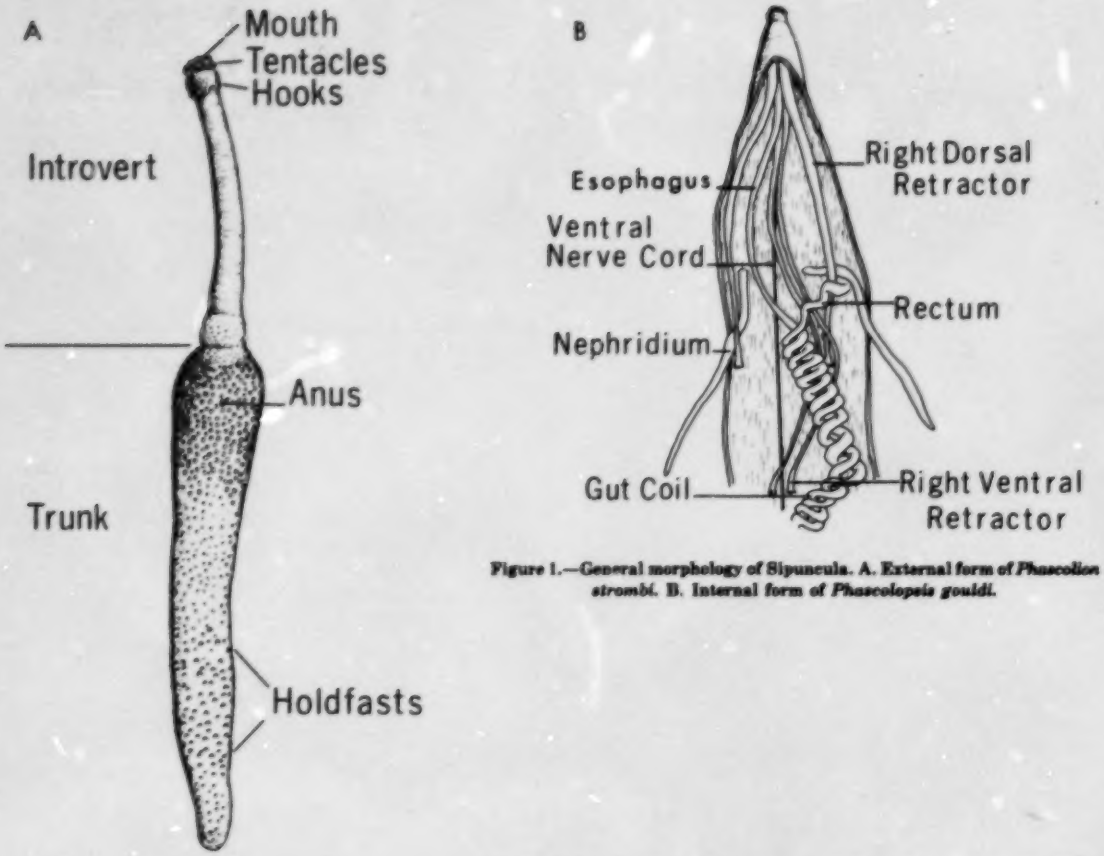


Figure 1.—General morphology of Sipuncula. A. External form of *Phascolion strombi*. B. Internal form of *Phascolopsis gouldi*.

exception of *G. minuta*, sipunculans are dioecious and lack any sexual dimorphism. The gametes are retained in the coelom until mature then released through the nephridiopores, fertilization occurring externally. Free-swimming trochophore larvae generally occur but some brooding of early stages within the maternal "home" (crevice or hole in substrate) has been observed in *G. minuta* and may occur in other cold- or deepwater forms. After metamorphosis, the juveniles settle onto a suitable substratum and probably remain in that immediate vicinity throughout their lives. Our knowledge of growth rate or longevity is nonexistent.

Sipunculans are either filter or deposit feeders, depending on the species. The filter feeders have a more elaborate tentacular apparatus than the deposit feeders. As such, these worms play their part in the recycling of detritus and probably consume smaller invertebrates in the process. They are in turn preyed on by fish and probably other predators. It has been reported in the literature that sipunculans are used as food for man in Indonesia and the Indo-Pacific (Hyman 1959) and are also used as fish bait in these regions.

The methods for collecting Sipuncula vary according to the area. *Phascolopsis gouldi* can be collected with a shovel at low tide; in warmer waters intertidal forms often inhabit coral or rock which must be carefully broken with a hammer. To collect the deeper dwelling species a dredge or trawl is required. These should be equipped with a fine mesh bag (less than 2 mm) to retain the smaller individuals. The sediment is then gently washed through a sieve (1 mm or less) and the remaining material inspected with a dissecting microscope. Initial fixation should be with 4% formaldehyde but, if possible, should be preceded by a 30-60 min period of narcotization with a compound such as menthol crystals or a dilute solution (5-10%) of ethanol and seawater, to allow the introverts to protrude. This greatly facilitates identification. For long-term storage 70% ethanol should be used.

In order to identify most animals to species, dissection is required. The recommended procedure is to find the dorsal anus and make an incision down the dorsal side passing just to the left of the anus, thereby avoiding the internal organs.

Hyman (1959) gave a general account of the biology of the sipunculans. Gerould (1913) and Cutler (1973) have discussed the western North Atlantic fauna in more detail. Stephen (1960) has brief descriptions of all these species except *Phascolopsis gouldi*. Stephen and Edmonds (1972) presented the most comprehensive treatment of the phylum, but it is not without error. Theel (1905) contains good illustrations and descriptions of all the species discussed here except for *P. gouldi*. Stephen

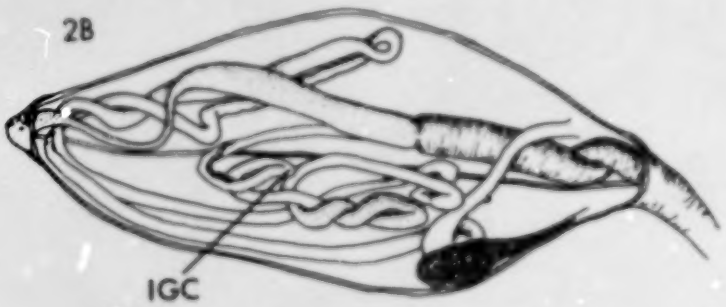
(1964) first proposed that the proper spelling of this phylum is Sipuncula, familiarly known as sipunculans. This usage has been accepted by specialists but has been slow to spread throughout the biological community.

The five species found in the area between Maine and Virginia to a depth of 200 m are all common forms, four of them being found in all major oceans. One, *P. gouldi*, is endemic to the Atlantic coast of the United States and is rare south of Long Island. *Onchnesoma steenstrupi* and *Golfingia catharinae* are common on the continental slope but occasionally occur on the outer shelf southeast of Long Island. Because they are restricted to the outer shelf and occur there only infrequently, they have not been included here (see Cutler 1973).

KEY TO THE SIPUNCULA, MAINE TO VIRGINIA

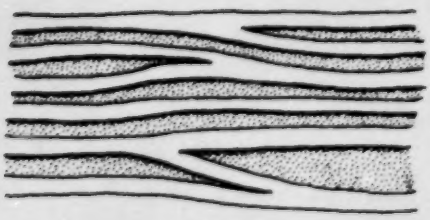
This is an artificial key designed only for the identification of the five inshore species found in the area covered by this manual. Accurate identification requires a well-preserved, entire organism with the internal parts intact. If the introvert is not fully extended, the nature of the tentacles can usually be determined by dissection of the retracted introvert. Measurements given are trunk lengths of average adults.

1 Trunk surface with chitinized epidermal structures (holdfasts) as in Figures 1A and 2A; one nephridium; irregular gut coils (Fig. 2B IGC); usually living in mollusc shell; 3-15 mm . . *Phascolion strombi*



1 Trunk surface without chitinized epidermal structures; two nephridia; regular double helix of gut coils (Fig. 1B); usually living in sediment 2

2 (*1*) Longitudinal body musculature separated into distinct bundles (Fig. 3A); common in shallow subtidal waters; up to 130 mm (Fig. 3B) . . . . . *Phascolopsis gouldi*



2 (*1*) Longitudinal body musculature forms continuous sheet; rare in water less than 10 m deep 3

3 (2) Introvert with two pair of retractor muscles (dorsal and ventral, Fig. 1B); 5-25 mm (Fig. 4) . . . . . *Golfingia margaritacea*

4

3 (2) Introvert with one pair of retractor muscles (ventral only) 4

4 (3) Trunk smooth; well-developed tentacles as in *G. margaritacea*; mature forms are stout with thick body walls; free-living; 5-25 mm (Fig. 5) . . . . . *Golfingia eremita*

5

4 (3) Posterior of trunk may have papillae; tentacles reduced to lobes (Fig. 6A); small (2-10 mm) and slender with thin body walls (Fig. 6B); sometimes found in hyalinaceous polychaete or arenaceous foraminiferan tubes . . . . . *Golfingia minuta*

6A

6B

ANNOTATED SYSTEMATIC LIST OF SPECIES

Phylum Sipuncula

This taxon has been considered to be at a variety of systematic levels and has been spelled many ways at various times in the past. Since its elevation to the rank of phylum there has been a void of intermediate taxa. The description of families occurred recently (Stephen and Edmonds 1972), but there are still no orders or classes.

Family SIPUNCULIDAE

Phascolopsis gouldi (Pourtales 1851)

Endemic to the western North Atlantic, common in southern New England, scattered reports south of lat. 30°N; no sexually mature forms known south of Cape Hatteras; depth 0-165 m, most common in shallow water; sediment-gravelly sand to silty sand; temperature range 0-25°C.

During the past 100 yr this species has been assigned to the genera *Sipunculus*, *Phascolosoma*, and *Golfingia*. The most recent shift (Stephen 1964) elevated *Phascolopsis* from subgeneric to generic rank. This is now a monotypic genus. I believe this is a mistake and that it is more closely related to *Siphonosoma*; until we better understand the development of *Siphonosoma* I have not suggested this change (see Cutler 1973). It is unfortunate that a species so commonly used by experimental biologists has undergone so many generic changes. Andrews (1890) presents a detailed account of the anatomy of this species.

Family GOLFINGIIDAE

Golfingia (*Golfingia*) *margaritacea* (Sars 1851)

A widely distributed species found in all oceans but most common in the North Atlantic and absent from the tropics; along the coast from Maine to Cape Hatteras, on the outer shelf and upper slope; sandy sediments; temperature range 2-12°C. Several dubious subspecies, forms, and varieties have been described in the literature for this widespread form.

Golfingia (*Phascoloides*) *eremita* (Sars 1851)

Common on both sides of the North Atlantic up into the Arctic Ocean, one record from 500 m off California; on the east coast from Maine to Cape Hatteras, rare south of Long Island; outer shelf and slope; sandy-silt sediment; temperature range 0-10°C.

Golfingia (*Phascoloides*) *minuta* (Keferstein 1865)

From Maine to North Carolina, also in the eastern North Atlantic to lat. 70°N, Mediterranean, off South Africa and Chile; 1-3,750 m, uncommon on the shelf; medium sand-silt sediment; temperature range 0-10°C. This is a poorly understood species and opinions vary as to its nature. Gerould's (1913) *G. cinctum* is definitely a synonym and *G. improvisa* (Theel) may be a synonym but this question is unresolved (see Cutler 1973). A discussion of the history of *Golfingia minuta* and *G. improvisa* can be found in Murina (1958).

Phascolion strombi (Montague 1804)

Common on the shelf from Maine to Long Island (rare on Georges Bank), ranging in deeper water to North Carolina (lat. 32°N); common throughout the Atlantic from the Arctic to the Antarctic, one record from the Pacific off southern Chile; depth 14-3,800 m; temperature range 2-26°C. This is the most common, eurythermal, eurybathyl, and morphologically plastic species in the area (Gerould 1913, Cutler 1973).

SELECTED BIBLIOGRAPHY

ANDREWS, E. A.
1890. Notes on the anatomy of *Sipunculus gouldii* Pourtales. Stud. Biol. Lab. Johns Hopkins Univ. 4:384-430.

CUTLER, E. B.
1973. Sipuncula of the western North Atlantic. Bull. Am. Mus. Nat. Hist. 152:105-204.

GEROULD, J. H.
1907. The development of Phascolosoma. Zool. Jahrb., Abt. Anat. Ontogen. Tiere 23:77-162.
1913. The sipunculids of the eastern coast of North America. Proc. U.S. Natl. Mus. 44:373-437.

GIBBS, P. E.
1975. Gametogenesis and spawning in a hermaphroditic population of *Golfingia minuta* (Sipuncula). J. Mar. Biol. Assoc. U. K. 55:69-82.

HYMAN, L. H.
1959. The protostomatous coelomates—phylum Sipunculida. *In* The invertebrates, Vol. 5, p. 610-696. McGraw-Hill Book Co., N.Y.

MURINA, V. V.
1958. On the systematics of two closely related species of the deep-water sipunculids of the genus Golfingia according to the materials of the "Vitiaz" expeditions in 1949-1955. [In Russ.] Zool. Zh. 37:1624-1633.

RICE, M. E.
1967. A comparative study of the development of *Phascolosoma agassizii*, *Golfingia pugettensis*, and *Themiste pyroides* with a discussion of developmental patterns in the Sipuncula. Ophelia 4: 143-171.
1973. Morphology, behavior, and histogenesis of the pelagosphera larva of *Phascolosoma agassizii* (Sipuncula). Smithson. Contrib. Zool. 132, 51 p.
1975. Observations on the development of six species of Caribbean Sipuncula with a review of development in the phylum. *In* M. E.

Rice and M. Todorovic (editors), Proc. Int. Symp. Biol. Sipuncula and Echiura, Vol. 1, p. 141-160. Naunco Delo Press, Belgrade.

STEPHEN, A. C.

1960. British echiurids (Echiuroidea), sipunculids (Sipunculoidea), and priapulids (Priapuloidea). Synopses Br. Fauna 12:1-27.

1954. A revision of the classification of the phylum Sipuncula. Ann. Mag. Nat. Hist., Ser. 13, 7:457-462.

STEPHEN, A. C., and S. J. EDMONDS.

1972. The phyla Sipuncula and Echiura. Trustees Br. Mus. (Nat. Hist.), Lond., 528 p.

THEEL, H.

1906. Northern and Arctic invertebrates in the collection of the Swedish State Museum I. Sipunculids. K. Sven. Vetenskapakad. Handl. 39:1-130.

INDEX TO SCIENTIFIC NAMES

Golfingia
eremita 4,5
margaritacea 4, 5
minuta 1, 2, 4, 5
Golfingiidae 5
Phascolion
strombi 3, 5
Phascolopsis
gouldi 1, 2, 3, 5
Sipunculidae 5

ACKNOWLEDGMENTS

Preparation of the "Marine Flora and Fauna of the Northeastern United States" is being coordinated by the following board:

Coordinating Editor: Melbourne R. Carriker, College of Marine Studies, University of Delaware, Lewes, DE 19958.

Editorial Advisers: Marie B. Abbott, Marine Biological Laboratory, Woods Hole, Mass.
Arthur G. Humes, Boston University Marine Program, Marine Biological Laboratory, Woods Hole, Mass.
Wesley N. Tiffney, Department of Biology, Boston University, Boston, Mass.
Ruth D. Turner, Museum of Comparative Zoology, Harvard University, Cambridge, Mass.
Roland L. Wigley, National Marine Fisheries Service, Biological Laboratory, Woods Hole, Mass.
Robert T. Wilce, Department of Botany, University of Massachusetts, Amherst, Mass.

The Board established the format for the "Marine Flora and Fauna of the Northeastern United States," invites systematists to collaborate in the preparation of manuals, review manuscripts, and advises the Scientific Editor of the National Marine Fisheries Service.

The completion of this paper was made possible by the assistance of Norma J. Cutler. The artwork was done by Mary Ann Pritchard and Henry Iwanicki.

COORDINATING EDITOR'S COMMENTS

Publication of the "Marine Flora and Fauna of the Northeastern United States" is most timely in view of the growing universal emphasis on environmental work and the urgent need for more precise and complete identification of coastal organisms than has been available. It is mandatory, wherever possible, that organisms be identified accurately to species. Accurate scientific names unlock the great quantities of biological information stored in libraries, obviate duplication of research already done, and often make possible prediction of attributes of organisms that have been inadequately studied.

Edward B. Cutler began his studies of Sipuncula in 1964 as a participant in the International Indian Ocean Expedition. As a graduate student at the University of Rhode Island he worked with several large collections from eastern North American and Bermudan waters. That work was published in 1973. His ongoing research is related to the systematics and zoogeography of the Indian Ocean and the sub-littoral Atlantic Ocean Sipuncula. Particular attention has been paid to the slope fauna off the Carolinas. He has been at Utica College of Syracuse University since 1967.

Preparation of this manual was supported in part by a grant from the Environmental Protection Agency to the Editorial Board of the "Marine Flora and Fauna of the Northeastern United States." Work on the "Marine Flora and Fauna of the Northeastern United States" by the Coordinating Editor is supported by the College of Marine Studies, University of Delaware.

Manuals are available for purchase from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The manuals so far published in the series are listed below.

COOK, DAVID G., and RALPH O. BRINKHURST. Marine flora and fauna of the Northeastern United States. Annelida: Oligochaeta.
BORROR, ARTHUR C. Marine flora and fauna of the Northeastern United States. Protozoa: Ciliophora.
MOUL, EDWIN T. Marine flora and fauna of the Northeastern United States. Higher plants of the marine fringe.
McCLOSKEY, LAWRENCE R. Marine flora and fauna of the Northeastern United States. Pycnogonida.
MANNING, RAYMOND B. Marine flora and fauna of the Northeastern United States. Crustacea: Stomatopoda.
WILLIAMS, AUSTIN B. Marine flora and fauna of the Northeastern United States. Crustacea: Decapoda.
POLLOCK, LELAND W. Marine flora and fauna of the Northeastern United States. Tardigrada.
LARSON, RONALD J. Marine flora and fauna of the Northeastern United States. Cnidaria: Scyphozoa.
CAVALIERE, A. R. Marine flora and fauna of the Northeastern United States. Higher fungi: Ascomycetes, Deuteromycetes, and Basidiomycetes.
COULL, BRUCE C. Marine flora and fauna of the Northeastern United States. Copepoda: Harpacticoida.
CUTLER, EDWARD B. Marine flora and fauna of the Northeastern United States. Sipuncula.

★ U.S. GOVERNMENT PRINTING OFFICE: 1977—797-854/22 REGION 10

388. Proceedings of the first U.S.-Japan meeting on aquaculture at Tokyo, Japan, October 18-19, 1971. William N. Shaw (editor). (18 papers, 14 authors.) February 1974, iii + 133 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

389. Marine flora and fauna of the northeastern United States. Crustacea: Decapoda. By Austin B. Williams. April 1974, iii + 50 p., 111 figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

390. Fishery publications, calendar year 1973: Lists and indexes. By Mary Ellen Engett and Lee C. Thorson. September 1974, iv + 14 p., 1 fig. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

391. Calanoid copepods of the genera *Spinocalanus* and *Mimocalanus* from the central Arctic Ocean, with a review of the Spinocalanidae. By David M. Damkaer. June 1975, x + 88 p., 225 figs., 4 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

392. Fishery publications, calendar year 1974: Lists and indexes. By Lee C. Thorson and Mary Ellen Engett. June 1975, iv + 27 p., 1 fig.

393. Cooperative Gulf of Mexico estuarine inventory and study—Texas: Area description. By Richard A. Diener. September 1975, vi + 129 p., 55 figs., 26 tables.

394. Marine Flora and Fauna of the Northeastern United States. Tardigrada. By Leland W. Pollock. May 1976, iii + 25 p., figs. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

395. Report of a colloquium on larval fish mortality studies and their relation to fishery research, January 1975. By John R. Hunter. May 1976, iii + 5 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.